

**UNIVERSIDAD DEL CEMA**  
**Buenos Aires**  
**Argentina**

Serie  
**DOCUMENTOS DE TRABAJO**

**Área: Economía y Negocios**

**THE CHANGING STRUCTURE OF PRODUCTION:  
ARGENTINE AGRICULTURE 1988-2002**

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**Diciembre 2009**  
**Nro. 415**

**[www.cema.edu.ar/publicaciones/doc\\_trabajo.html](http://www.cema.edu.ar/publicaciones/doc_trabajo.html)**  
UCEMA: Av. Córdoba 374, C1054AAP Buenos Aires, Argentina  
ISSN 1668-4575 (impreso), ISSN 1668-4583 (en línea)  
Editor: Jorge M. Streb; asistente editorial: Valeria Dowding <[jae@cema.edu.ar](mailto:jae@cema.edu.ar)>



# **The Changing Structure of Production: Argentine Agriculture 1988 – 2002 <sup>1</sup>**

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## **Abstract**

The agricultural sector of many countries shows increasing farm size with corresponding decrease in farm numbers. Despite abundant research, the determinants of changes in firm numbers and size have not been clearly identified. This paper attempts to explain small firm survival in Argentine agriculture in the 1988 – 2002 period. The evidence suggests that labor market considerations, as well changing optimal size in response to production specialization are important factors affecting small-firm disappearance. In contrast, factor proportions (the K/L ratio) does not appear to have an impact on changes in firm size.

Keywords: economies of scale, Argentine agriculture, agricultural labor markets.

JEL: D2, Q12

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<sup>1</sup> The views presented here are of the author and not necessarily of the University of CEMA

## I. Introduction

Firm size distributions change through time. This is true of all sectors of the economy: auto plants, retail stores, the service industry (e.g. restaurants) and of course agriculture. Understanding the determinants of such changes is of considerable interest to economists, as it bears upon aspects such as capital constraints, asset fixity, technology adoption, management and control, the role of human capital in production and many others. The size-efficiency linkages, however, are not clear cut. In auto manufacturing, for example, changes in the organization of production (in particular, the reduction in the extent of vertical integration) appear to have reduced the optimal size of plants if not of firms (The Economist, 2002). In other industries opposite forces may be at work: in many countries retail stores appear to grow in size, gradually displacing small family firms. Economies in market procurement, in the use of shelf space, in inventories or in consumer “effort” for purchasing may explain this trend.

The agricultural sector has been subject to numerous studies related to firm scale and efficiency (see, e.g. Kiselev and Peterson, 1991, MacDonald, Hoppe and Banker, 2004). In some sub-sectors (e.g. poultry, or up to a point dairy production) the evidence supporting the efficiency of larger units is quite clear-cut (Doll and Orazem, ch.7). These sub-sector are characterized by relatively “capital-intensive” technology (high capital/land and capital/labor ratios). Moreover the production technology is “semi-industrial”: standardized processes, materials taken to machines and animals instead of the other way round, single-as opposed to multiproduct orientation, contracts with output purchasers, etc.

In contrast with the above, agricultural sub-sectors such as grain crops and pasture-fed livestock production are characterized by multi-output firms highly dependent on random weather factors. In these firms land (a heterogeneous and spatially dispersed production factor) is an important input in production. These and other characteristics seem to favor relatively smaller scale. Schmitt (1986, 1991) has argued that family farms are efficient and survive because labor markets allow family labor to be allocated efficiently among farm-

and non-farm uses. Given a stock of fixed resources (land and/or capital) labor will be allocated among alternatives so as to equate marginal productivities, hence allocative efficiency is achieved. In larger production units, adjustment will result in a smaller portion of family labor allocated to off-farm work, or labor will be hired to complement that supplied by the farm family. The possibility of equating labor productivity in on- and off-farm use results in both “small” and “large” units co-existing.

The above model is possibly one explanation for the persistence of many production units; however increased farm size seems to characterize farms of many parts of the world. In the U.S., the number of farms decreased from 7 million in the 1930’s to less than 2 million in 2002 (MacDonald, Hoppe and Banker, 2004). A similar pattern appears in Argentina, where farm numbers peaked at 550,000 in 1966, falling to less than 300,000 in 2002 (Gallacher, 2008). Understanding the determinants of these changes is not easy: in American agriculture, for example, farm numbers have decreased (with a corresponding increase in farm size) despite research results reporting constant returns to scale.<sup>2</sup> Theoretical cost curves are a guide to inquiry, however applying these concepts to real-world situations calls for considerable ingenuity: aspects such as constraints to asset mobility, asset “lumpiness” or differential adjustment to new technologies may all be at work in affecting optimal firm size, and observed size distribution of firms over time.

This paper is focused on the driving forces that underlie changes in the structure of production of Argentine agriculture. An attempt is made to identify reasons for the decrease in farm numbers observed during the past decades. Issues that need addressing include: (a) is growth in firm size associated with changes in factor proportions, (b) what part does the functioning of agricultural labor and capital service markets play in changes in firm size and (c) has adaptation to changing profit opportunities affected firm size. The paper is organized as follows. Section II summarizes changes that have occurred in the

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<sup>2</sup> For the U.S., Heady (1952) presents early (1940’s and early 1950’s) evidence of constant returns to scale in agriculture. Kislev and Peterson (1991) discuss the constant returns hypothesis with evidence up to the late 1980’s.

agricultural sector, and attempts to link these to changes to farm numbers. In Section III specific hypothesis related to the dynamics of firm size are presented. Section IV summarizes empirical analysis; conclusions are in Section V.

## **II. Changing structure of production in Argentine agriculture**

In the early 1970's Alain de Janvry explained the lack of progress in Argentine agriculture as a result of insufficient and mis-directed public-sector investment in modern agricultural technology (de Janvry, 1973). The argument presented was that larger farmers did not face incentives conducive to pressuring the public-sector research system for the development of modern production systems. Small farmers, it was argued, lacked the political clout to affect research allocation priorities. The "induced innovation" model developed by de Janvry possibly explains what happened until the late 1960's, however the last four decades have witnessed changes in technology and productivity that have resulted in significant increases in the price of land, thus benefiting producers that – according to de Janvry's induced innovation hypothesis – were more resistant (or at least indifferent) to change. Indeed, the fall in the number of small as opposed to larger farms further suggests that technological progress benefited the latter as opposed to the former.

Lack of appropriate technology was a retarding factor in agricultural growth. However, output and input markets (as de Janvry recognizes) also played a role. The dynamics of fertilizer use illustrates this point. In the early and mid-1970's, fertilizers were used very sparingly in extensive (non-irrigated) crops: demand totaled some 70,000 tons. Reduction in fertilizer prices (resulting from a fall in import taxes) as well as increased availability of fertilizer-responsive seeds resulted in a rapid and continuous increased in the use of these inputs: in 2006 total use was some 3.5 million tones, that is some seventy times the level used three decades earlier. In an early paper White (1977) shows the major differences in input/output prices faced by Argentine farmers as compared to other major grain exporters: for example, an Argentine farmer had

to sell 12 – 14 kg of wheat to purchase a kg of nitrogen fertilizer, as compared to less than 5 by his French or American counterpart.

New technologies resulted in a reduction in the demand for farm labor as well as tillage services: “minimum tillage” and “no-tillage” production was practically non-existent in the mid to late 1980`s, but represented some 70 percent of planted area in 2005 (AAPRESID, undated). Under these new tillage systems, total labor use of the most important grain crops fell from some 3.0 – 3.5 to 1.0 hours per planted hectare. This reduction in labor use results in labor costs representing no more than 5 - 10 percent of total costs of production (excluding land). The low level of labor use can be put into perspective by considering that in a “medium” sized crop farm (of say, 500 planted hectares) annual labor use for planting and crop protection is not more than 1000 hours, clearly well below the 2.000 – 2.200 hours worked by a full-time employee.

Although labor-saving technological change predominated until the late 1950`s, farm numbers appear to have increased during this period from some 300,000 farms in the early 20<sup>th</sup> century, to 550,000 in 1966.<sup>3</sup> Labor- and land-saving technological change gathered steam from the 1960`s onward and this was accompanied by farm numbers declining from the 550,000 mentioned above (1966) to less than 300,000 in 2002. Table 1 shows farm numbers and size for 1988, 2002 and 2008 in the most important production zone of the country (the “pradera pampeana”).<sup>4</sup> As shown, in the main grain-producing areas of the country (provinces of Buenos Aires, Córdoba and Santa Fé) farm numbers in 2002 were 65 to 75 percent of those in 1988.

The above can be summarized as follows. First, a steady stream of new technologies was adopted by farmers during the last four decades. Technology adoption probably took place at different rates among firms: access to know-how and financing are two constraints that impinge to a greater extent in some farms than in others. Second, a significant reduction in labor use has taken place. This is a result of: (a) increased use of high-capacity capital inputs and (b) change in

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<sup>3</sup> Substitution of tractor for animal land preparation (until the 1930`s) and the introduction of mechanical harvesting (1940`s and 1950`s) were the main labor-saving technologies.

<sup>4</sup> Data for 2008 are preliminary and according to some observers, of questionable accuracy.

technology, in particular a shift from mechanical to chemical – based crop production systems. Reduction in labor use results in a labor surplus situation: in order to equalize input productivity with opportunity costs, either farm assets have to be increased, or reallocation of labor and management to other uses has to occur. Lastly, in some areas farms have increased their degree of specialization. Specialization is a result of two processes: (a) “mixed” crop-livestock farms are increasingly focused on crops and (b) furthermore, the mix of crops in part of the production area shows a reduction of cereals and an increasing proportion of oilseeds (in particular soybeans). As in industry, specialized technology allows larger-scale production to take place through increased use of standardized processes and control. Coordination with input suppliers (including service suppliers) is also facilitated.

### **III. Explaining changes in farm size**

The size distribution of firms observed in a given time period (“ $t_1$ ”) is a result of: (a) the distribution of firms existing in an “initial” time period (“ $t_0$ ”, for convenience, consider this exogenously determined) and (b) the impact of economic forces acting on firms of different sizes during  $t_0 - t_1$ . As pointed out by Stigler (1958), the existence of heterogeneous resources implies that no “one” is optimal: two firms differing in size and in “ex-post” estimated average costs may in fact have similar economic costs if resources were valued at true “ex-ante” implicit prices.<sup>5</sup> The “survival technique” approach proposed by Stigler recognizes these difficulties, and will be used in the empirical analysis presented below.

The basic decision the producer makes relates to land area to be farmed and the contractual agreement to be used in payment for land, labor and capital services. The producer may expand by renting additional land (by various contractual agreements) or may alternatively contract by renting to others land

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<sup>5</sup> Why firms use different proportions of heterogeneous resources raises an “academic” problem: under cost minimization, and assuming a homogeneous technology and equal input prices factor proportions of different-sized firm should be identical. Economic models are of course very useful; however, the correspondence between these models and real-world conditions may be tenuous.



owned by himself. Increase in farm size and corresponding farm numbers results from control of land being transferred (by land rental or outright purchase) from smaller- to larger than average producers. Firm size expansion as defined above focuses on the control of land. However, capital inputs (farm machinery) are also necessary in the production process. Given the multiple-output nature of the agricultural firm, firm expansion may in some cases imply contraction in the use of land and expansion in the use of capital: the firms' output may increasingly be composed of the production machine-services (for other firms) instead of agricultural products. Adjustment is then one of increased specialization: control of land is concentrated in fewer firm numbers, while simultaneously the same occurs with the control of capital inputs used in the production process.

### Capital/Labor Substitution

The substitution of capital for labor observed during the last decades is a possible determinant of changes in firm size. Capital services used by farm firms are non-specific: no "hold-up problem" (Williamson, 1985) exists between purchasers and purveyors of these services. This allows an active rental market to develop, however set-up, supervision and coordination costs result in higher total cost, per unit of service, for small as compared to larger firms. If the "firm" considered is the vertical unit composed of the service- plus the commodity-producing firm, average cost of output falls as size of this unit increases. The resulting economies are a consequence not only (or necessarily) of the increased efficiency of large- as compared to small- machines, but of the lower fixed cost of coordinating service flows from these machines in larger as compared to smaller production units.<sup>6</sup>

Coordination costs, in particular, may be an issue: machinery services have to be allocated in a timely fashion among plots of land. If these plots belong

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<sup>6</sup> Consider as an example fertilizer application: hiring this service eliminates the need of owning application equipment, but requires metering if quantity applied by the hired contractor is what was agreed upon. A "small" producer (who possibly has other activities in addition to agriculture) may find this metering costly. If firm size increases, supervision can be "spread out" over a larger number of purchased service units.

to different farmers an allocation mechanism has to be designed (“first come first served”, “old customers first” etc). Ideally services could be allocated among farmers on an auction basis; however this may prove costly. An alternative is for the “n” plots under the control of different farmers to be merged into one under the control of an overall manager: coordination is achieved here via centralized administrative decision as compared to the various “personal bargaining” solutions used previously.

In summary, the falling price of capital in relation to labor results in capital - labor substitution. In turn, efficient use of capital inputs results in increasing separation in the ownership/management of these inputs, on the one hand, and of land inputs on the other. Economies of scale in the production of machinery services (custom machinery operators), coupled with fixed costs in delivering these services to individual firms lead to consolidation of commodity-producing firms. Furthermore, increasing separation facilitates (a) higher throughput of capital services and (b) benefits from the specialized managerial/entrepreneurial function in both service and commodity-producing firms.

### Adaptability

The second force explaining falling farm numbers relates to adjustment under uncertainty, in particular to increased profit opportunities opened up by production technologies. Cost adjustments mentioned previously are a function, in particular, of changing input price ratios and the “lumpiness” in the production of capital services. In contrast, adjustment under uncertainty is a function not only of these variables but of changing input productivity (which requires adaptive ability). Farmer education and access to private consulting services are important determinants of the adoption of new technologies. Furthermore farm size is correlated both to education as well as to access to these information-providers

The price of land (either for rental or outright purchase) results from expectations which differ among decision-makers. If “small scale” entrepreneurs lag behind in technology adoption, or if they discount risky returns more heavily

than entrepreneurs managing larger enterprises, control of land can be expected to migrate from smaller to larger producing units: reduction in the number of smaller enterprises, and growth in size (or in numbers) of larger-sized units is the result. Speed of this adjustment process will depend on outside opportunities of exiting farmers. Improved access to labor markets will increase out-migration, and increased sector-specific capital will reduce it. In particular, quasi-rents associated with sector-specific capital will result in higher survival rates of small commodity-producing firms.

### Specialization

Reduction in the number of different outputs produced, and/or of different technologies used results in a fall in supervision and coordination costs. In the agricultural sector, “specialized” firms such as feedlots, sugar plantations or poultry operations tend to have larger size (measured for example by sales) than multi-output crop/livestock units. A-priori then, the specialization that has occurred in a large part of the Argentine agricultural area should favor increases in firm size.

## **IV. Empirical Analysis**

We seek to explain determinants of changes in the size distribution of firms in the main production area of Argentina. Due to data availability, we focus attention on the period 1988 – 2002. This period is particular interest as it includes important changes that took place in macroeconomic policy: beginning in 1991, these include monetary stabilization, deregulation and privatization as well as increased openness to trade. Changes affecting the agricultural sector included elimination of export taxes, reduction in the price of imported inputs and increased access to medium-term financing. According to some observers, the relative capital/labor price fell, from the late 1980`s to the mid 1990`s, by 30 – 40 percent (Bour, 1994).

Graph 1 summarizes changes that have taken place in the size distribution of firms the 1988 – 2002. Histograms were constructed on the basis of “partido” or “departamento” (“county”) data. These correspond to political/administrative units each comprising several hundreds of farms. The variable analyzed is the ratio of “small” (< 200 hectare) firm numbers in 2002 as compared to 1988, and the ratio of land resources controlled by these firms in these two time periods.<sup>7</sup> As shown, considerable difference exists in the survival rate of small firms: in approximately one-fifth of the *partidos* more than 75 percent of small firms survived in this 13-year period. But, in a similar percentage of cases, less than 45 percent of firms survive. As shown, the modal survival rate is 60 – 70 percent, that is some 40 – 40 percent of firms have ceased production.

If survival is analyzed on the basis of changes in land resources controlled by small firms the pattern is similar. However the distribution shifts to the right: survival rate is somewhat “higher” as measured by resources controlled than by firm numbers. This possibly results from exiting firms being smaller than all firms that in 1998 controlled 200 or-less hectares.

Data pertaining possible determinants of changes in the distribution of firm size are shown in Table 2. Family labor in 2002 is some 10 – 12 percent of that reported in 1988. These figures probably exaggerate the reduction in this input, as the census does not estimate time actually worked, but the “stock” of family labor allocated to production. Most probably, the extent to which the stock was used in 1988 was lower than in 2002. However, even allowing for mis-measurement, an important fall in family labor use is apparent. The reduction in non-family labor is significant and larger in “small” (less than 200 hectares) than in all farms: in 2002, non-family labor was reduced by one-half in the former and by one-third in the latter.

Total capital stock increased by 35 percent in small and nearly 50 percent in all farms. Improvements in the efficiency of agricultural machinery suggest that these figures under-estimate the “true” increase in productive capacity. More

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<sup>7</sup> “Small” firms are defined here as those totaling less than 200 hectares. Graph 1 includes data from the provinces of Buenos Aires, Córdoba and Santa Fé.

importantly, the shift from tillage-based to chemical-based crop production resulted in a dramatic increase in the productivity of capital inputs: as mentioned previously, labor-hour requirements dropped – as a result of chemical-based technologies – to less than one half of previous levels. Increases in capital stocks, coupled with reductions in labor inputs resulted in increases in capital stock per worker: as shown, in the 1988 – 2002 period this metric increased four-fold in all farms, and nearly eight-fold in (surviving) small farms. Small farms surviving in 2002 thus are considerably more “capitalized” than those existing in 1988.

Human capital figures should be interpreted with caution: they appear to the author lower than expected. More detailed information on how the questionnaire was administered is necessary to elucidate this issue. With this caveat, it appears that the gap between average and small-farm educational levels has increased over time. Possibly, surviving small farms have - relative to those ceasing production – lower levels of general human capital, differential off-farm opportunity cost being a relevant variable guiding allocation of family labor to farm and non-farm uses. In relation to this point, the percentage of farmers reporting non-farm time allocation shows a small decline. Differences in time allocation between small and all farms are minor in 1988, and practically non-existent in 2002. The (weak) trend suggests increasing specialization in agricultural production.

Capital-labor substitution occurring in the 1988-2002 period is shown in Graph 2.<sup>8</sup> Y-axis depicts the ratio of 2002 to 1988 labor, X-axis the change in K/L ratio between these two periods ( $K/L_{2002}/K/L_{1988}$ ). The pattern that emerges is quite clear: increases in K/L are accompanied by decreases in L. Estimating “by eye” from the graph, a doubling of the K/L ratio (for example from 1 to 2) results labor falling to one-half (from 1 to 0.5). The resulting “elasticity of substitution” is then  $0.50/(1+0.5)/(1/(1+2)) = 1$ . This “rough and ready” elasticity of substitution among inputs is only illustrative; however it corresponds to what results from a

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<sup>8</sup> Graph 2 includes data from the provinces of Buenos Aires and Córdoba. Santa Fé is excluded because capital data for 1988 are unavailable.

Cobb-Douglas technology, a widely used functional form in applied production analysis. An implication of this elasticity value is that relative income shares to capital and labor will be independent of relative factor prices.

Regression analysis is used to test the significance of selected variables on firm survival. No explicit micro optimizing model is presented; however the following economic forces are explored:

1. Substitution of capital for labor allows reductions in average cost of production; however these reductions are scale-dependent. This occurs because set-up, supervision and coordination costs associated with the use of higher capital/labor ratios are proportionally higher in smaller as compared to larger production units.
2. Off-farm opportunity costs increase farmer education. Small-farm survival rates will be negatively related to this variable, as the marginal productivity of this human capital is greater in off- than in on-farm allocation (constraints on land and capital availability limit the impact of human capital on farm production).
3. Sector-specific capital increases survival possibilities of small commodity-producing firms. This occurs through two channels. First, quasi-rents associated with this capital reduce incentives to migrate. Second, sector-specific capital in period  $t_0$  facilitates investment in additional capital of this type: not only capital constraints are less intense the more capital is available, but also know-how in managing this type of capital is presumably a function of the amount of existing capital.
4. Specialization allows increased standardization of production methods. As in industrial production, increased specialization is expected to have a greater impact on high versus low output firms. "Diseconomies" due to managerial limitations are expected to be less of an issue the higher the extent of production specialization.
5. Differential perception of technological opportunities, as well as differential capacity to adapt to these opportunities exists. This differential capacity

results in resource re-allocation from smaller to larger firms or, alternatively, it results in the “merging” of small firms. In both cases, the number of small firms falls.

The survival of firms through time is presumably associated with their cost and profit structure. An index of the relative profitability of firm size “*i*” can be thus defined as the change in the number of firms of the group in two time periods:

$$(1) IP_i = N_{i1}/N_{i0}$$

Where the “*i*” superscript defines a given firm size (small, large) and the subscripts 0 and 1 define two time periods, and  $N_{it}$  is the number of firms the *i*-th strata. If  $IP_i < 1$ , firm numbers (or resource controlled) by the *i*th farm strata are falling, which implies resource productivity is lower in this group than in alternative uses.

Devising metrics for factors (1) – (5) above depends on data availability. The following indexes are used here:

1. Capital/labor ratio (K/L): the hypothesis to be tested is that a change in the intensity of capital use (capital/labor ratio) is a variable affecting optimum firm size.
2. Farmer education (HC) is taken as a proxy for general human capital. The hypothesis predicts a higher exit rate of small firms with increases in this variable.
3. The stock of agricultural machinery in period  $t_0$  ( $KS_0$ ) of small-firms measures sector-specific capital. The hypothesis is that an increase in  $KS_0$  increase small-firm survival.
4. Specialization: indexes of specialization in land use ( $Sc = \text{crop acreage}/\text{total acreage}$ ) and in crop production ( $Ss = \text{soybean acreage}/\text{crop acreage}$ ) capture possible impact of increased specialization on firm size.

5. Adjustment to uncertainty (ChTec): growth in output per unit of land is taken as a proxy of the rate of inflow of new technologies. This growth rate is then defined as:  $(Y_1/T_1)/(Y_0/T_0)$  where Y is an index of crop production, and T is land in planted hectares.
6. Additional variables are included in order to capture effects that a-priori appear of potential importance. These are: (i) the extent of the market for machinery services (an output of particular importance for land-constrained firms), (ii) the extent of the use of private consulting services in the region (a measure of supply and demand of modern know-how), (iii) an index of the diffusion of chemical-based tillage methods (an important labor- and durable-capital saving technology) and finally (iv) a measure of the participation of farm producers in the non-farm labor market. This variable is possibly correlated with the human capital variable previously mentioned, however it may “pick-up” different effects relative to resource allocation.

The following regression model is used:

$$(2) IP_i = f(K/L, Ks_0, HC, Sc, Ss, Ch, Serv, Cons, NoTill, NonFarm)$$

Where:

K/L = Change in the K/L ratio (2002/1988)

Ks<sub>0</sub> = Durable capital (small farms, 1988)

HC = Farmer education (small farms, 1988)

Sc = Specialization, crops (Cropland/Total Land, 2002)

Ss = Specialization, soybeans ( $\Delta$ Soybeans 1988-2002/Cropland 1988)

Ch = Land productivity growth 1988/2002

Serv = Supplied + demanded custom machine services as % of cropland

Cons = % farms using consulting services

NoTill = no-tillage diffusion, 2002 (no-till hectares/planted hectares)

NonFarm = % farmers with non-farm work



Data for the provinces of Buenos Aires and Córdoba are used ( $n = 110$ ). Unfortunately capital data (1988) is unavailable for Santa Fé (an important province). Results are shown in Table 3. The dependent variable is the ratio of small farms in 2002 and 1988. This regression focuses on “small” (< 200 hectares) farm survival, and is based on the “survivor” concept of firm size dynamics. The F-value is significant at  $p = 0.01$ . However, R-sq is low (20 percent). Possible measurement errors (further discussed below) as well as “what is attempted to explain” (changes in farm size) may be an underlying cause this result. Model results are as follows:

- Changes in the K/L ratio do not appear to have affected firm survival. This finding suggests that capital intensity of production is not a relevant factor in returns to scale: the rental market for capital services possibly operates smoothly, eliminating part of the “lumpiness” associated with capital items.
- The initial capital stock of small firms ( $K_{s0}$ ) shows “wrong” sign: small firm survival falls as small firm capital stock increases. A possible rationalization for this result is that increasing specialization has occurred among firms: small, “capital abundant” firms have expanded via the production of custom services, land being re-allocated from these firms to (larger) commodity-producing units that contract out most machine services.
- Production specialization appears a relevant variable explaining small firm survival: specialization in crops is significant ( $p = 0.10$ ), and specialization in soybeans, while not significant at conventional probability levels has a t-value greater than 1.2: weak evidence of the (negative) impact of specialization on soybean production on firm survival can thus be inferred. Increase in land productivity (a rough measure of “technical change”), on the other hand, does not have a significant effect. The same occurs to the no-till technology diffusion index.

- Labor-market variables bear scrutiny as determinants of small-firm survival: the small-firm human capital is significant at  $p = 0.15$ , the off-farm labor participation at  $p = 0.05$ . The t-values of the small-firm human capital variable, and the off-farm allocation of labor indicate that labor market, as opposed to pure “technological” (e.g. the K/L ratio) are important determinants of continuing operation of small firms: opportunity cost considerations of the farm family plays an important part.
- Lastly, a “weak” effect of private consulting services reducing small-firm survival is apparent ( $t = 1.53$ ). The consulting services variable can be interpreted as a proxy for the demand of “new” information in each of the “partidos”. If larger units have easier access to these inputs, a reduction in small-firm survival could – as appear to be the case here – occur in production areas where supply/demand of new technology is particularly intense.
- Empirical results presented here should be interpreted with caution: census data on firm numbers and planted area by farm size class are possibly subject to quite large errors as preliminary evaluation of the data base suggests to the author that some numbers do not “add-up”. This issue will be addressed in future research.

## V. Conclusions

Understanding the determinants of firm size and the changing distribution of firm size through time remains an important issue for economists to address. Textbook discussions are a useful starting point however; most of these focus almost exclusively on the geometry of cost curves vis-à-vis the underlying forces that determine how costs change as a function of output. Empirical analysis presented here suggests that labor-market forces, in particular, are an important determinant of the survival of “small” (defined here as less than 200-hectare) farms. Higher human capital in these farms and more fluid access to labor markets results in a lower number of these farmers continuing production.

Production specialization also seems to be associated with firm growth. In contrast with the above, factor proportions (the capital-labor) ratio do not appear statistically significant in explaining firm disappearance. This finding is somewhat surprising. However one explanation is that rental markets for capital services operate efficiently, “lumpiness” being then not an important issue.

Beginning in the 1980’s, but particularly in the 1990s and 2000s, very large business units (many of them not owning productive assets but renting these) have started to operate in Argentine agriculture. These “financial pools” as they are known, channel short- and medium term investor funds into crop production. Informal inquiry suggests that as of 2009, some 5 percent of total area was controlled by these business units. These pools spread out their resources anywhere from 10,000 to more than 250,000 planted hectares, renting land from landowners, contracting machinery services, hiring crop supervisors and arranging multiple contractual forms with suppliers of fertilizers, seeds, herbicides and other production inputs.<sup>9</sup> The “logic” behind these enterprises has been subject to considerable debate; however it is not clear whether this type of organization will ultimately displace family firms that traditionally have formed the back bone of the agricultural sector.

In agricultural economics, the economies-of-size literature has focused attention on the owner-operated farm-firm. In modern agriculture a significant portion of capital services (planting, weed control, harvesting) is delivered by outside contractors. Understanding size-efficiency issues will require looking not only to the commodity-producing firm but to how these interact with outside contractors, and in particular looking into the market for contracting services. The existence of scale efficiencies in the production of contracting services can possibly “spill over” to efficiencies in crop production, therefore explaining the reduction in the number of firms through time.

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<sup>9</sup> In 2009, six firms farm each more than 100,000 hectares (one of these plants 260,000 hectares). Some 15 additional firms plant each 35,000 – 60,000 hectares. Alejandro Bustamante, personal communication. (2009).

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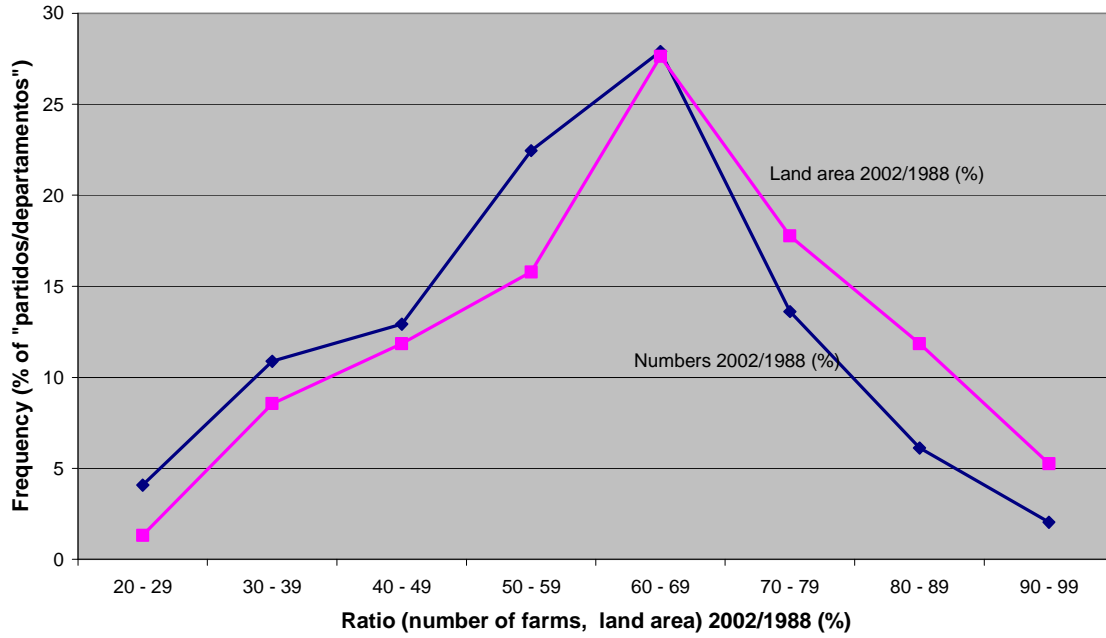
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**Table 1: Changing Farm Numbers**

Province		Census year				
		1988	2002	2008	02/88 (%)	08/02 (%)
<b>Santa Fe</b>	Number of Firms	36862	28103	26551	76	94
	Size (hectares)	300	400	406	133	101
<b>Entre Rios</b>	Number of Firms	27132	21577	17711	80	82
	Size (hectares)	228	294	316	129	108
<b>La Pampa</b>	Number of Firms	8631	7775	7502	90	96
	Size (hectares)	1444	1638	1556	113	95
<b>Cordoba</b>	Number of Firms	40061	26226	25910	65	99
	Size (hectares)	343	467	437	136	94
<b>Buenos Aires</b>	Number of Firms	75479	51116	31711	68	62
	Size (hectares)	361	505	550	140	109

Source: Instituto Nacional de Estadísticas y Censos INDEC), Censo Nacional Agropecuario 1988, 2002 and 2008

**Graph 1: Small-farm (< 200 ha) survival: numbers and land area**  
 ("partido/departamento" data of Buenos Aires, Córdoba and Santa Fé)



**Table 2: Input Trends (\*)**

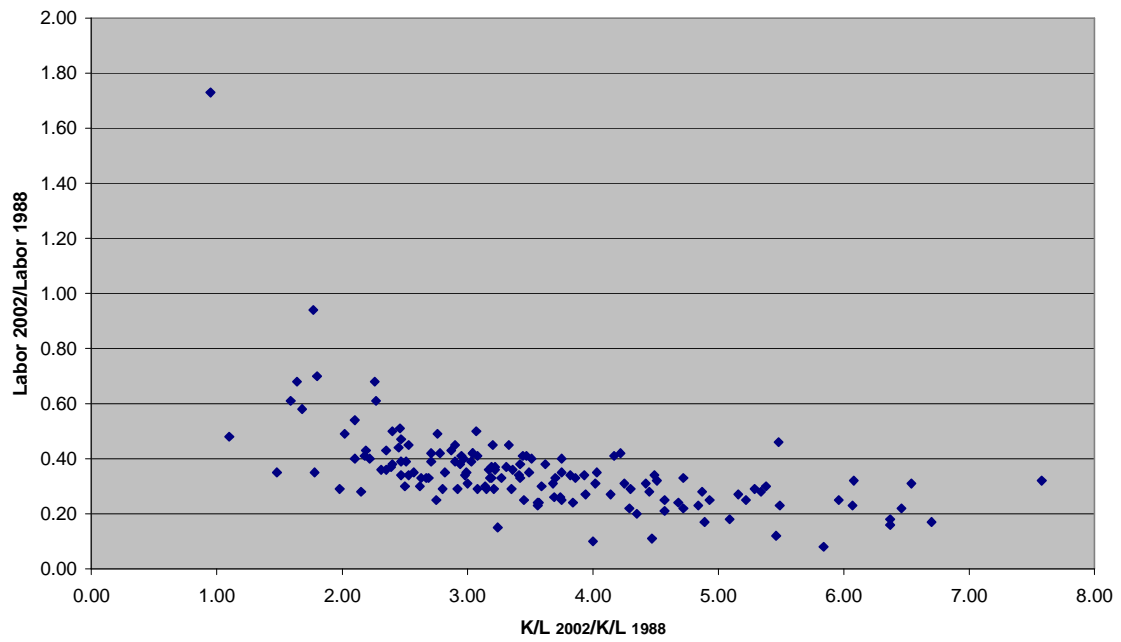
	1988	2002	2002/1988
<b>Family Labor (1988 = 100)</b>			
All farms	100	12	0.12
Small farms	100	10	0.10
<b>Non-Family Labor (1988 = 100)</b>			
All farms	100	64	0.64
Small farms	100	45	0.45
<b>Capital (1988 = 100)</b>			
All farms	100	147	
Small farms	100	135	
<b>Capital/Labor ratio (HP/Worker)</b>			
All farms	28	124	4.44
Small farms	17	129	7.61
<b>Human Capital (years schooling)</b>			
All farms	7.7	9.6	1.25
Small farms	7.1	8.6	1.21
<b>Off-farm allocation of operator labor (% of farms)</b>			
All farms	24	21	0.88
Small farms	27	22	0.81

(\*) Provinces of Buenos Aires and Córdoba

Source: INDEC, Censo Nacional Agropecuario 1988 and 2002



**Graph 2: Capital-Labor substitution**  
(**"partido/departamento"** data of Buenos Aires and Córdoba)



### Table 3: Regression Results

(provinces of Buenos Aires and Córdoba)

Dependent Variable: Ratio small farms 2002/1988  
("small": < 200 hectares)

	Bi	t-value	Significance
<b>Constant</b>	109.67	6.62	0.00
<b>K/L</b>	-1.11	-0.66	0.51
<b>Ks0</b>	-0.19	-2.04	0.04
<b>HC</b>	-2.67	-1.49	0.14
<b>Sc</b>	-0.27	-2.11	0.04
<b>Ch</b>	-0.01	-0.41	0.69
<b>Serv</b>	0.00	1.59	0.11
<b>Ss</b>	-0.01	-1.24	0.22
<b>NoTill</b>	0.00	0.25	0.80
<b>Cons</b>	-0.13	-1.53	0.13
<b>Non-Farm</b>	-0.31	-2.06	0.04

Adj Rsq: 0.13  
F-value: 2.65 (sig p=.05)  
Number of observations: 110